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MAPPING AND SURVEY REQUIREMENTS FOR A LAND UTILIZATION AND DEVELOPMENT PROJECT

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MAPPING AND SURVEY REQUIREMENTS FOR A LAND UTILIZATION AND DEVELOPMENT PROJECT

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1. Introduction

In 1948 the Department of Lands and Survey undertook the development of some 500,000 acres of virtually virgin country in the North Island of New Zealand. This project was for the settlement of ex-servicemen from World War II. The land had been mainly undeveloped because it was considered to be "stock-sick". This was due to mineral deficiencies, the surface soils being chiefly pumice formed by comparatively recent volcanic showers. The 500,000 acres was not one compact block but a number of individual blocks ranging in area from a few hundred acres up to about 40,000 acres, dispersed over a region of some 5,000 square miles. It ranged in altitude from near sea level to about 3,000 feet, the vegetation cover being mainly heavy scrub and fern with some areas of native bush. It was considered that with modern techniques and the application of the necessary trace elements in conjunction with aerial topdressing, this unused land could be quickly converted to fertile sheep and dairy farms.

Topographical map cover was practically non-existent, the few maps available covering only a very small area. Scale was 1:63,360 with sketch contours at 100 feet vertical interval. On one development block some 1:7,920 mapping with 25 feet contours was available. Cadastral map cover at 1:63,360 scale was available over the whole area but this was of little use for planning and carrying out development. Much of the information shown, in the way of roads and section boundaries was not defined on the ground. Topographical information such as streams and bush edges, was often inaccurate. The entire area was covered by a net of first-order triangulation, there was no modern second or third order work. Some parts were covered by very old third order work which was not connected to the geodetic framework and which was generally not very reliable. A certain amount of cadastral survey information was available for horizontal fixation but this also was not in terms of the geodetic triangulation and many of the ground marks had been lost or destroyed. Basic vertical aerial topography by Eagle IV cameras with 8¼" lens and a negative scale of approximately 1:15,840, was available over most of the area. A start had been made on the production of semi-controlled mosaic maps at 1:15,480 scale and even though much of the photography was up to 8 years old, the extension of this mosaic map cover as rapidly as possible was the first essential.

2. Planning Requirements

(a) Land Utilization Survey

An overall analysis of the potential uses of the land must be based on factual data such as provided by a land utilization survey. Usually this would cover fully such aspects as tenure, population distribution, soil types,

climate, vegetation and topography. On this particular project we were concerned only with the undeveloped Crown and Maori lands and such private land as had been offered to the Crown. With the aid of existing aerial photos and maps, supplemented by a general field reconnaissance, the area was broadly classified into the following categories:-

(i) Land capable of immediate development
(ii) Land suitable for later development
(iii) Land unsuitable for development

This survey showed that approximately half of the area was suitable for immediate development. This was not confined to a particular area but was dispersed throughout the various blocks.

(b) Land Classification Survey

The next step was a detailed land classification survey based on the overall land utilization data and what detailed knowledge of the terrain that could be gained from studying the aerial photos, mosaics and other existing maps.

The land was classified as follows:-

(i) Land which could be ploughed
(ii) Land which could be giant disced
(iii) Land which could be surface sown after burning
(iv) Land which was to remain in bush
(v) Land which was useless for farming

Where suitable topographic maps were not available the individual pairs of photos were examined with a pocket stereoscope for general classification and the information transferred to the mosaic maps. Even when topographic maps were available the aerial photos were invaluable in supplementing the information from the maps. Where semi-controlled mosaics were not available, pin-up mosaics were useful. The vegetation cover and the land slopes determined largely the methods to be adopted in bringing the land under development. During this survey the surveyor's report covered in considerable detail the following aspects:-

Soil types, vegetation cover, land form, water supply, access, proposed land use and sizes of farming units, possible township and reserve sites etc.

(c) Overall Coordination

In the region under consideration a number of hydro-electric stations were either under construction or being planned and there were extensive areas of exotic forests, some being the largest man-made forests in the world. The overall coordination on a regional basis, especially on aspects of communications and future township requirements, was of the greatest importance. The roading pattern was generally determined by the sizes of the farming units and although in the initial stages it was seldom possible to locate finally all subdivisional roading, the surveyor would indicate possible access routes, particularly those which might develop into arterial roads.

3. Map Requirements

(a) General Planning

Ideally, both medium and small scale topographic maps are required to show the present and assess the future potential of such a project. The map scales would be dependent upon the size of the areas being developed and their relation to the surrounding region. Cadastral maps at 1:63,360 and 1:253,440 were the only maps available giving complete cover over the region. The national topographic mapping is based on a National Yard Grid, a 1:63,360 sheet covering 45,000 yards by 30,000 yards, the contour interval being 100 feet. These sheets are subdivided into nine 1:25,000 sheets covering 15,000 yards by 10,000 yards, the contour interval being 50 feet. For the general planning of an area such as this, 500,000 acres dispersed over 5,000 square miles, scales of 1:63,360 and 1:253,440 were satisfactory, but the initial lack of complete topographic map cover was a very big handicap.

(b) Detailed Planning

Mapping at 20 chains to an inch, 1:15,840 with V.I. 50 feet, was proposed for the detailed planning. The farm units varied in size from about 100 acres up to 600 acres and while this scale was satisfactory for planning the sheep units it proved to be too small for the dairy units. The final title surveys have in many instances disclosed considerable differences between the planned and surveyed areas. Much of the country was suitable for both sheep or dairy farming and the preliminary schemes of subdivision often had to be changed from sheep to dairy or vice versa due to circumstances outside of the surveyor's control. It was not possible to have two mapping scales for the detailed planning, one for sheep and the other for dairy, and the 1:15,840 scale was a compromise.

No use was made of mosaic maps for the final subdivisional planning, as the only ones available were semi-controlled, 1:15,840 scale, with probable errors of up to 10 per cent. I am now convinced that on the easier flattish country where the proposed land use does not entail irrigation or river control works, detailed contoured topographic maps are unnecessary and that fully controlled mosaic maps would be sufficiently accurate and prove more useful. They could be produced in a fraction of the time and cost required for topographic mapping with the added advantage that more use could be made of them by untrained or semi-trained personnel working on the project.

(c) Records

Maps for recording the progress of the various stages of development operations are essential, and here again the 1:15,840 scale was used. A transparency was prepared from the topographic maps and the periphery of each development block plotted from cadastral survey data, in ink. Proposed schemes of subdivision were drawn in pencil and, as any survey work was finalised it was inked up. A mounted print taken from the transparency was used to record all details such as cultivation and aerial sown areas. The transparency was kept up-to-date and details such as fences, buildings, water supplies, etc., added as they were fixed in the field, and up-to-date prints were thus available at any time. Plans of all cultivation and other contracts fixed by the survey staff were prepared and recorded for each separate development block.

4. Aerial Survey Requirements

Prior to 1956 the vertical aerial photography was Eagle IV, 8¼ inch focal length, negative scale approximately 1:15,840. Since then the RC 5.a camera has been used to take both Aviogon 4½ inch for mapping purposes and Aviotar 8¼ inch for mosaic mapping. The value of the vertical air photo during all stages of land development cannot be over-emphasised. In the preliminary planning stages even a rough pin-up mosaic is useful while the semi-controlled ones are invaluable. Fully controlled mosaics based on slotted templet control could play a vital part in any land development project. The main advantages over the conventional topographic map would be rapid production; low cost; the simplicity in using a photo instead of a map by untrained personnel such as farm supervisors, contractors, etc. If air photos are taken at various stages of development a great amount of ground survey can be dispensed with as the information can be obtained from the photos in a fraction of the time otherwise required and at a much lower cost.

5. Survey Requirements

(a) Overall Control

This condition was satisfied by the existing 1st order triangulation covering the region which had been carried out in recent years to international geodetic standards. The polygon system was used with sides varying from about 20 to 50 miles in length. The average triangle closure was less than 1 second and the maximum less than 3 seconds. Some precise levelling to international standards of accuracy had been carried out in conjunction with the extensive hydro-electric investigations being undertaken in this region.

(b) Breakdown for Mapping and Survey

No tellurometer was available in the initial stages. As the old 3rd order triangulation was not connected directly to the geodetic net and in some areas was unreliable, the first step was to breakdown to 2nd and 3rd order triangulation. The 2nd order was a direct breakdown from the geodetic net, i.e., fixed angle and length equations were possible between the 1st order stations through the 2nd order net. Similarly, the 3rd order was a direct breakdown from the 2nd with the exception that some 3rd order stations were fixed by intersections from at least 3 occupied stations. The 3rd order net was sufficiently dense for all mapping and most survey purposes. Tellurometer traverses between triangulation stations, as a means of thickening up control where necessary for detailed survey, have since proved most successful. Undoubtedly, it is a more rapid and more economic method than conventional triangulation breakdown, and probably more accurate as well. The elevations obtained from the trigonometrical levelling were sufficiently accurate for both mapping and land development purposes generally. For the specific engineering surveys connected with this project such as roading, water-supply, topdressing airstrips, etc., engineering levelling to an accuracy of 0.2 foot per mile run, was quite sufficient. All control stations were permanently ground marked and located so as to be as free as possible from future disturbance. Buried marks were placed under all stations.

6. Survey Equipment and Methods

(a) Control Surveys

The 2nd and 3rd order breakdown was carried out with Wild T 3 theodolites. Observations were taken during the day, the instruments being sheltered from sun and wind by an observing tent. Wooden quadripod beacons were erected at each station for sighting to, and were of two sizes - a 10 ft one under which the instrument could be set up and a 5 ft one which had to be removed in order to set up centrally. Under average conditions the 10 ft beacon was visible for 20 miles and the 5 ft beacon for 10 miles. Owing to atmospheric conditions, observations, except on cloudy days, could generally only be carried out in the early mornings and late afternoons. Whenever possible the vertical angles were measured near midday. The advent of the tellurometer has speeded up control survey work to a great extent. Simple traverses have proved effective and closes better than 1.50,000 can be readily obtained with a single measurement and 12 fine readings. If a geodetic framework is already established, there would seem little point in using the rather more accurate geodimeter in preference to the tellurometer which can operate under a wider range of conditions.

(b) Breakdown for Mapping and Survey

If aerial photos are to be used for mapping some photo control points must be fixed by ground survey. Normally this was done by resecting to at least four previously established stations with a second reading theodolite such as a Wild T2. It was seldom possible to select a suitable control point which could be occupied by the instrument, and the theodolite was usually set up at a sub-point and the connection made to the photo control point by direct or subtense measurement. A levelling staff graduated in feet on one side and links on the other was useful for this work. A ground mark such as an iron tube or spike was inserted at the instrument station to serve as a control station for future detailed surveys such as compass traverses. Diagrams of the points identified with their coordinates and heights were listed on the back of the photo and in addition, coordinate and height data for all control points listed for each flight on special forms. The use of the tellurometer for directly fixing mapping and detailed survey control by simple traversing between established stations has also proved to be economic and accurate.

(c) Detailed Survey

Most of the development improvements such as fences, buildings, roads, water supplies, etc., were fixed by magnetic compass and chain traversing. These traverses were closed on to established control such as trigonometrical stations, tellurometer traverse stations, photo control points and cadastral survey stations. This was a slow method, subject to considerable sources of error and one that could be largely superseded if new air photos were taken from time to time, and simple equipment such as a radial-line plotter were available. The use of fully controlled mosaic maps would enable additional improvements to be plotted with sufficient accuracy with a minimum of field work and by comparatively untrained staff.

7. Mapping Equipment and Methods

In the initial stages of the project some plane-tabling was carried out in an endeavour to increase the total mapping output, the bulk of which was being done by photogrammetric methods. For plane-tabling, minor control plots were first prepared and adjusted to fit adjoining strips by graphical

methods, as no slotted templet assembly was available. All planimetric detail on the photos was then plotted, and the contouring, with Indian clinometers, done in the field. Mapping production by this method was slow, especially as few trained staff were available. All departmental survey cadets were attached to this project for training purposes, usually 3 months on triangulation and 3 months on mapping.

Mapping at 1:15,840 scale and 50 ft vertical interval was also carried out with A5, A6 and Multiplex equipment. Wild A7 and A8 instruments have since been acquired. The specifications for ground survey required an accuracy in position of ± 2 yards, and in height of ± 3 feet. The ground survey work, which is always rather a bottleneck in mapping, was very considerably reduced when the Aviogon photography became available. In rough, remote areas and where vegetation cover makes access difficult, the photogrammetric method is without doubt superior in all respects to a ground method such as plane-tabling. Since most land development projects would include country of this nature the choice of method seems clear.

New photography at 1:15,840 scale is obtained at various stages of development and is used by the field survey staff in conjunction with simple equipment such as the radial line plotter, to fix new improvements and to measure areas of cultivation contracts. As development progresses there is usually sufficient survey information available to enable the new photo centres to be readily fixed.

8. Summary and Conclusion

(i) Whatever the type of development or the mapping method envisaged, vertical air photography should be available.

(ii) Topographic maps are desirable for the general planning but they are not essential for the detailed planning of all land development areas. On areas of low relief and where the proposed land use does not necessitate accurate contour information, fully-controlled mosaic maps would be more useful and could be produced more rapidly and more economically than topographic maps. Where topographic maps are required they are best produced by photogrammetric methods from wide-angle or super wide-angle photography.

(iii) Where possible the scales of topographic and mosaic maps required for detailed planning should be directly related to the sizes of the proposed farm units, and not necessarily be required to conform to the scales required for national mapping.

(iv) The use of electronic distance measuring equipment would enable all control, overall, mapping or survey, to be established more rapidly and more economically than is possible by conventional methods.

(v) The use of simple photogrammetric equipment such as radial line plotters and slotted templet, used in conjunction with air photography taken at various stages of development, would reduce considerably the requirements for detail survey.

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